

# PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2000-350390

(43)Date of publication of application : 15.12.2000

(51)Int.Cl.

H02K 1/16

H02K 1/12

H02K 19/10

(21)Application number : 11-158605

(71)Applicant : DAIKIN IND LTD

(22)Date of filing : 04.06.1999

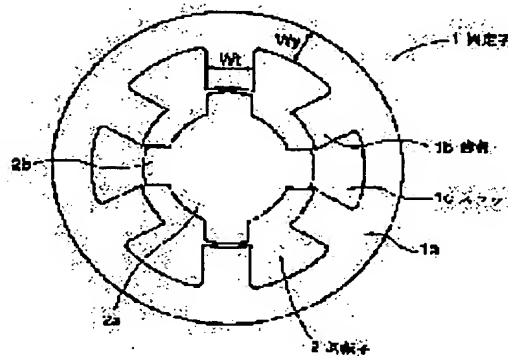
(72)Inventor : NISHIMOTO TAKEAKI  
YAMAI HIROYUKI

## (54) SWITCHED RELUCTANCE MOTOR

(57)Abstract:

**PROBLEM TO BE SOLVED:** To increase efficiency, and to decrease noise by specifying the ratio of the width of the tooth part of a stator to back yoke width.

**SOLUTION:** An SR motor is in a 6-pole type, and six inward tooth parts 1b are formed in one piece at even intervals for a cylindrical back yoke part 1a. Also, the SR motor is equipped with a stator 1 where stator coil winding is wound to a slot part 1c being formed by two blade parts 1b adjacent to the back yoke part 1b, and a rotor 2 where, for example, four outward tooth parts 2b are formed in one piece at even intervals for a columnar body part 2a. Then, when the thickness of the back yoke part 1a (back yoke width) and the width of the tooth part (tooth part) are set to  $W_y$  and  $W_t$ , respectively, a ratio  $a(=W_y/W_t)$  of the back yoke width  $W_y$  to the tooth width  $W_t$  should be set to 0.8 to 1.4, thus minimizing the reduction of slot area and the increase of a copper loss, at the same time, relieving flux concentration, preventing the increase of flux density, and reducing an iron loss.



## LEGAL STATUS

[Date of request for examination] 08.05.2001

[Date of sending the examiner's decision of rejection] 30.04.2002

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]

**\* NOTICES \***

JPO and NCIP are not responsible for any damages caused by the use of this translation.

1. This document has been translated by computer. So the translation may not reflect the original precisely.
2. \*\*\*\* shows the word which can not be translated.
3. In the drawings, any words are not translated.

---

**CLAIMS**

---

[Claim(s)]

[Claim 1] While winding the stator winding around the slot (1c) which prepares the tooth part (1b) which projects in the inside sense for every predetermined spacing in the inside of a stator (1), and is specified inside by the tooth part (1b) It is the switch TORIRAKU wardrobe motor which comes to prepare a rotator (2) in the interior of a stator (1). the ratio of the width of face Wt of the tooth part (1b) of a stator (1), and the width of face Wy of a back yoke (1a) -- the switch TORIRAKU wardrobe motor characterized by setting Wy/Wt as the predetermined value which can attain efficient-izing and low noise-ization.

[Claim 2] the ratio of the width of face Wt of the tooth part (1b) of a stator (1), and the width of face Wy of a back yoke (1a) -- the switch TORIRAKU wardrobe motor according to claim 1 which set Wy/Wt to 0.8 or more and 1.4 or less.

[Claim 3] The switch TORIRAKU wardrobe motor according to claim 2 which has set aforementioned ratio Wy/Wt to 0.8 or more and 1.0 or less.

[Claim 4] The switch TORIRAKU wardrobe motor according to claim 2 which has set aforementioned ratio Wy/Wt to 1.0 or more and 1.4 or less.

[Claim 5] A switch TORIRAKU wardrobe motor given in any of claim 1 to claim 4 which has formed the flat-surface section (1f) they are that it should be made to correspond to the base of a tooth part (1b), and reduction of the width of face Wy of a back yoke (1a) should be compensated while having formed the plane core cut (1e) in the external surface of the back yoke (1a) corresponding to the tooth part (1b) of a stator (1).

---

[Translation done.]

## \* NOTICES \*

JPO and NCIP are not responsible for any damages caused by the use of this translation.

1. This document has been translated by computer. So the translation may not reflect the original precisely.
2. \*\*\*\* shows the word which can not be translated.
3. In the drawings, any words are not translated.

---

## DETAILED DESCRIPTION

---

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to new SR motor compatible in the low noise and a well head, if it says further a detail about a switch TORIRAKU wardrobe motor (SR motor is called hereafter).

[0002]

[Description of the Prior Art] SR motor is a motor which generates torque, when the magnetic flux passing through the magnetic circuit formed as each stator winding by which the concentration volume was carried out to the slot of a stator was excited discretely and it was shown in drawing 23 changes.

[0003] here, since magnetic flux  $\phi_0$  generated in the tooth part (refer to A in drawing 23) is made right and left in the back yoke section for 2 minutes, if the thickness (width of face)  $W_y$  of the back yoke section shown in drawing 24 is set or more [ of the width of face  $W_t$  of a tooth part ] to  $1/2$ , it can pass smoothly the magnetic flux  $\phi_0$  generated in the tooth part, without carrying out magnetic saturation in the back yoke section namely,

[0004] If this configuration is adopted, the back yoke section is saturated ahead of a tooth part, there is no un-arranging [ that torque decreases ], slot area becomes max, reduction of the coil resistance by the increment in the amount of coils can be attained, and copper loss is made to min, as a result efficient-ization of SR motor can be attained.

[0005] However, when SR motor was made as an experiment as mentioned above, compared with the conventional motor (an induction motor, brushless DC motor) of the same output, it turned out that about 10dB or more and the motor simple substance noise become large. This originates in the motor and drive method of others [ motor / SR ] differing from each other. the drive wave of SR motor, and electromagnetism -- relation with a suction force is shown in drawing 26. the lap of the salient pole section of a stator and a rotator becomes large -- following -- electromagnetism -- the place with which the suction force increased and the salient pole sections of a stator and a rotator lapped -- electromagnetism -- a suction force serves as max. this electromagnetism -- deformation (ellipse deformation) of the direction of a path is caused to a stator by the suction force. Since the location of this ellipse deformation changes whenever an excitation phase switches, it is operated repeating concavo-convex movement and a stator generates the noise. this was pointed out from the former as a trouble of SR motor proper -- it is inconvenient.

[0006] the approach (refer to JP,9-294359,A, JP,9-103055,A, JP,9-103056,A, and JP,2-119561,A) of performing (1) buffer and reinforcement as an approach proposed in order to make it canceling this to un-arrange and (2) -- electromagnetism -- the approach (refer to JP,9-331663,A) of reducing a suction force, the method (refer to U.S. Pat. No. 5266859 specification) of putting in (3) skews, and the approach (refer to JP,3-159531,A) of raising (4) rigidity are proposed. [ and ]

[0007]

[Problem(s) to be Solved by the Invention] Since shock absorbing material and reinforcing materials are needed in adopting the approach of the above (1), it not only causes the cost rise accompanying adopting these, but it will cause the increment in the man day for incorporating these.

[0008] the case where the approach of the above (2) is adopted -- electromagnetism -- there is un-arranging [ that generating torque will fall with the fall of a suction force ].

[0009] the electromagnetism which works between the stators and rotators which cause above (3) the ellipse deformation to which the noise of SR motor is made to increase -- although it is what distributes a suction force by the skew -- electromagnetism -- since it does not contribute to raising the rigidity of a motor at all so that clearly from the torque fall by distribution of a suction force, and a formula (1), it is thought that the noise in the resonant frequency of a motor cannot be reduced.

[0010] In adopting the approach of the above (4), there is un-arranging [ that effectiveness falls with the increment in back yoke width of face ].

[0011] The approach of the above (4) is explained further.

[0012] Generally, the noise can be reduced if the rigidity of a motor is raised. This is shown by

reference "Vibration Modes and Acoustic Noise in a Fore-Phase Switched Reluctance Motor" (IEEE TRANSACTIONS ON INDUSTRY, VOL.32, NOVEMBER/DECEMBER 1996). Specifically, the degree type showing the resonance angular frequency  $\omega$  is shown. For  $\omega^2 = (2 \times 1.04452 / 1.625\pi) \times (E/\rho) \times (t^2/R^4)$ , however  $E$ , Young's modulus and  $\rho$  are [ back yoke width of face and  $R$  of an ingredient consistency and  $t$  ] ring radii.

[0013] As shown in an upper type, in order to raise rigidity, without changing a motor outer diameter, it is needed to make back yoke width of face increase. However, if back yoke width of face is made to only increase as shown in drawing 27, slot area will decrease, the amount of coil wearing will decrease, and coil resistance will increase (it is an invitation about the increment in copper loss), as a result a motor efficiency will be reduced.

[0014] In addition, since thickness radial [ in the field of a height ] increases as one of the effectiveness by preparing a triangular projection between slots, JP,3-159531, A can raise rigidity, can fall the noise, but since slot area decreases as shown in drawing 28, and copper loss increases, it cannot avoid decline in effectiveness.

[0015] A noise reduction sake, Said reference "Vibration Modes and Acoustic Noise in a Fore-Phase Switched Reluctance It is based on the idea of Motor" (IEEE TRANSACTIONS ON INDUSTRY, VOL.32, NOVEMBER/DECEMBER 1996). Although the noise was able to carry out about 10 dBA reduction when the thickness  $W_y$  of the York section was set up so that it might become twice the width of face  $W_t$  of a tooth part and SR motor was made as an experiment, as shown in drawing 25, by having expanded back yoke width of face, slot area became small, copper loss increased, and effectiveness has fallen.

[0016] it had been thought like an approach since each \*\* of a more than that the coexistence with reduction of the noise and efficient-izing was impossible.

[0017]

[Objects of the Invention] This invention is made in view of the above-mentioned trouble, and it aims at offering SR motor which can reconcile reduction and efficient-izing of the noise.

[0018]

[Means for Solving the Problem] While SR motor of claim 1 is winding the stator winding around the slot which prepares the tooth part which projects in the inside sense for every predetermined spacing in the inside of a stator, and is specified inside by the tooth part, inside a stator the thing which comes to prepare the rotator which has the tooth part which projects outward for every predetermined spacing in the external surface of a rotator -- it is -- the ratio of the width of face  $W_t$  of the tooth part of a stator, and the back yoke width of face  $W_y$  --  $W_y/W_t$  is set as the predetermined value which can attain efficient-izing and low noise-ization.

[0019] SR motor of claim 2 -- the ratio of the width of face  $W_t$  of the tooth part of a stator, and the back yoke width of face  $W_y$  --  $W_y/W_t$  is set to 0.8 or more and 1.4 or less.

[0020] SR motor of claim 3 sets aforementioned ratio  $W_y/W_t$  to 0.8 or more and 1.0 or less.

[0021] SR motor of claim 4 sets aforementioned ratio  $W_y/W_t$  to 1.0 or more and 1.4 or less.

[0022] SR motor of claim 5 is made to correspond to the base of a tooth part, and forms the flat-surface section that reduction of the width of face  $W_y$  of a back yoke should be compensated while it has formed the plane core cut in the external surface of the back yoke corresponding to the tooth part of a stator.

[0023]

[Function] If it is SR motor of claim 1, while winding the stator winding around the slot which prepares the tooth part which projects in the inside sense for every predetermined spacing in the inside of a stator, and is specified inside by the tooth part It is the thing which comes to prepare a rotator with the tooth part which projects outward for every predetermined spacing on the external surface of a rotator in the interior of a stator. the ratio of the width of face  $W_t$  of the tooth part of a stator, and the back yoke width of face  $W_y$  -- since  $W_y/W_t$  was set as the predetermined value which can attain efficient-izing and low noise-ization, reduction and efficient-izing of the noise can be reconciled.

[0024] SR motor of claim 2 -- the ratio of the width of face  $W_t$  of the tooth part of a stator, and the back yoke width of face  $W_y$  -- since  $W_y/W_t$  was set to 0.8 or more and 1.4 or less, reduction and efficient-izing of the noise can be reconciled.

[0025] Furthermore, it explains.

[0026] the ratio of the width of face  $W_t$  of the tooth part of a stator, and the back yoke width of face  $W_y$  -- the relation between  $\alpha = W_y/W_t$  and electric loss (= iron loss + copper loss) of SR motor is given as shown in drawing 20. and this relation shows -- as -- a ratio -- in order that slot area may decrease with the increment in  $\alpha$  -- copper loss -- a ratio -- it increases with the increment in  $\alpha$ . on the other hand -- iron loss -- a ratio -- until  $\alpha$  is set to 1.4 -- a ratio -- although it decreases in monotone with the increment in  $\alpha$  -- a ratio -- even if  $\alpha$  exceeds 1.4, iron loss does not decrease any more. this -- a ratio -- drawing 21 which shows change of the flux density accompanying change of  $\alpha$  shows -- as -- a ratio -- if  $\alpha$  becomes 1.4 or more, change of the flux density of the back yoke section will become loose, and it is thought that it is because iron loss is generally proportional to the square of flux density.

[0027] moreover, drawing 20 shows -- as -- a ratio --  $\alpha$  -- the range of 0.4 or more and 1.4 -- electric loss of SR motor -- small -- further -- a ratio -- when  $\alpha$  is before and after one, electric loss of SR motor

serves as the minimal value.

[0028] furthermore, a ratio -- drawing 22 which shows change of the noise of SR motor accompanying change of alpha shows -- as -- a ratio, although the noise-reduction effectiveness of 7 or more dBAs can be acquired by making alpha or more into 0.8 a ratio -- since slot area decreases in electric loss of a motor so that alpha may be understood from drawing 20 in spite of there being little noise-reduction effectiveness also as 1.4 or more (2 - 3dBA extent), and copper loss increases, loss will increase.

[0029] therefore, a ratio -- the low noise and efficient-ization can be reconciled by setting alpha to 0.8 or more and 1.4 or less as mentioned above.

[0030] If it is SR motor of claim 3, since aforementioned ratio  $W_y/W_t$  was set to 0.8 or more and 1.0 or less and it is not necessary to use what low copper loss-ization can be attained, and generation of heat by the stator winding can be reduced in this case, as a result is borne to high temperature as an insulating material of SR motor, a cheap insulating material can be used.

[0031] If it is SR motor of claim 4, since aforementioned ratio  $W_y/W_t$  was set to 1.0 or more and 1.4 or less, low iron loss-ization can be attained and the magnetic steel sheet which consists of a cheap steel plate ingredient in this case can be adopted.

[0032] If it is SR motor of claim 5, while having formed the plane core cut in the external surface of the back yoke corresponding to the tooth part of a stator, that it should be made to correspond to the base of a tooth part, and reduction of the width of face  $W_y$  of a back yoke should be compensated, since the flat-surface section was formed, reduction of ingredient cost and improvement in handling nature can be attained, and also the same operation as any of claim 1 to claim 4 they are can be attained.

[0033]

[Embodiment of the Invention] Hereafter, with reference to an accompanying drawing, the mode of operation of SR motor of this invention is explained to a detail.

[0034] Drawing 1 is the sectional view of SR motor of this invention showing a configuration [ like ] roughly 1 operative condition.

[0035] While this SR motor is a 6 pole type thing and really coming to form tooth part 1b of the sense among six at equal intervals to cylinder-like back yoke section 1a It has the rotator 2 which really comes to form four outward tooth part 2bs at equal intervals to the stator 1 which comes to wind a stator winding (not shown) around slot section 1c formed by two tooth part 1b which adjoins back yoke section 1a, and cylinder-like body section 2a.

[0036] However, it is possible to adopt a 12 pole type configuration, as shown in drawing 2 , to adopt a 8 pole type configuration, as shown in drawing 3 , etc.

[0037] and the case where width of face (face width) of  $W_y$  and a tooth part is set to  $W_t$  for the thickness (back yoke width of face) of back yoke section 1a -- the ratio of the back yoke width of face  $W_y$  and a face width  $W_t$  -- alpha ( $= W_y/W_t$ ) is set to 0.8 or more and 1.4 or less.

[0038] If this configuration is adopted, reduction of slot area can be made into the minimum and the increment in copper loss can be made into necessary minimum. Magnetic-flux concentration is eased, the rise of flux density can be prevented to coincidence, iron loss can be reduced to it, and electric loss of a motor is not made to increase to it. Furthermore, as shown in drawing 2222 , the noise can be reduced by 7 or more dBAs. Therefore, the reduction in the noise and efficient-ization can be reconciled, without [ without it uses shock absorbing material and reinforcing materials leading to a cost rise, and ] reducing torque.

[0039] If the aforementioned ratio alpha is especially set to 0.8 or more and 1.0 or less, since low copper loss-ization can be attained and it is not necessary to use what generation of heat by the stator winding can be small carried out, as a result is borne to high temperature as an insulating material, a cheap insulating material can be used. On the contrary, if the aforementioned ratio alpha is set to 1.0 or more and 1.4 or less, since low iron loss-ization can be attained, the magnetic steel sheet which consists of a cheap steel plate ingredient is employable.

[0040] In addition, also in each following embodiment, the aforementioned ratio alpha is set to 0.8 or more and 1.4 or less. In addition, the above-mentioned knowledge can be concerned the different dental shape of a number or an appearance, and can be applied that there is nothing. Although various embodiments are shown below, in any case, the aforementioned ratio alpha is set up 0.8 or more and 1.4 or less.

[0041] Drawing 4 is the sectional view showing roughly the configuration of other embodiments of SR motor of this invention. In addition, the rotator has omitted illustration.

[0042] The point that this SR motor differs from SR motor of drawing 1 is only a point which made the rectangle the appearance of back yoke section 1a.

[0043] In this embodiment, although the thickness of back yoke section 1a changes with locations, the smallest thickness is adopted as back yoke width of face  $W_y$ . Moreover, 1d of through tubes is formed in four corners of back yoke section 1a.

[0044] In addition, it is possible also in the case of this embodiment, to adopt a 12 pole type configuration, as shown in drawing 5 , to adopt a 8 pole type configuration, as shown in drawing 6 , etc.

[0045] Drawing 7 is the sectional view expanding and showing the important section of the embodiment of further others of SR motor of this invention.

[0046] While this SR motor has given plane core cut 1e to the external surface of back yoke section 1a corresponding to tooth part 1b 1f (plane \*\*\*\* configuration) of flat-surface sections is formed instead of forming a hollow (R section) that reduction of the back yoke width of face by core cut should be compensated, as it is made to correspond to the base of tooth part 1b and a slash shows in drawing 7. It is made equal to the back yoke width of face [ in / for distance Wy' with 1f of this flat-surface section, and core cut section 1e / the non-core cut section ] Wy.

[0047] If this configuration is adopted, reduction of ingredient cost and improvement in handling nature can be attained by forming a core cut, and also it is compatible in the reduction in the noise, and efficient-ization.

[0048] Furthermore, it explains.

[0049] As shown in drawing 8, when a plane core cut is performed in the conventional SR motor, the distance Wy1 between the hollows (R section) and the core cut sections in the base of a tooth part is smaller than the back yoke width of face Wy in the non-core cut section.

[0050] And since back yoke width of face serves as Wy1 instead of Wy, magnetic flux is regulated between a hollow and the core cut section, and concentration of magnetic flux produces it. Consequently, iron loss increases and a motor efficiency falls. Moreover, since the thickness of the back yoke section is thin between a hollow and the core cut section, rigidity becomes weak and the noise and vibration increase.

[0051] Moreover, in order to cancel above un-arranging, as shown in drawing 9 R> 9, it can consider making the thickness of back yoke section 1a increase inside so that the distance between the core cut sections may serve as Wy, but in this case, since slot area decreases (the percentage reduction of slot area is about 22%), copper loss will increase and a motor efficiency will fall.

[0052] On the other hand, if the configuration of drawing 7 is adopted, since the percentage reduction of slot area is about 7%, reduction of slot area can be made into the minimum and the increment in copper loss can be controlled. Moreover, since magnetic-flux concentration is eased and the rise of flux density is prevented, iron loss can also be reduced. Consequently, if the increment in copper loss and reduction of iron loss are synthesized and evaluated, the decline in a motor efficiency will not be accepted as compared with the case where there is no core cut.

[0053] Moreover, since the \*\*\*\* configuration shown in drawing 7 is in the relation between a tooth part and a right angle, the alignment volume of a stator winding tends to carry out it, its space factor improves, since the slot bottom section is a straight line, and it can enlarge the amount of coil wearing, it can be contributed to reduction in resistance, and reduction of copper loss.

[0054] Drawing 10 is the sectional view expanding and showing the important section of the embodiment of further others of SR motor of this invention.

[0055] By making the predetermined range which follows tooth part 1b instead of a mere flat-surface configuration in the \*\*\*\* configuration of 1f into the flat surface which inclined in the inner sense, this SR motor breaks as a whole, and is made into the field configuration while it has formed 1g of semicircle column-like hollows in the center section of plane core cut section 1e. In addition, as for this sloping flat surface, the inclination is set up so that 1g [ of semicircle column-like hollows ] distance Wy'' may become equal to distance Wy' with a non-inclining flat surface among the plane core cut section and a \*\*\*\* configuration.

[0056] Therefore, also when this embodiment is adopted, while being able to make reduction of slot area into the minimum and being able to control the increment in copper loss, iron loss can also be reduced by easing magnetic-flux concentration and preventing the rise of flux density. Consequently, reduction of ingredient cost and improvement in handling nature can be attained by forming a core cut, and also it is compatible in the reduction in the noise, and efficient-ization.

[0057] Drawing 11 is the sectional view expanding and showing the important section of the embodiment of further others of SR motor of this invention.

[0058] By making the predetermined range which follows tooth part 1b instead of a mere flat-surface configuration in the \*\*\*\* configuration of 1f into the flat surface which inclined in the inner sense, this SR motor breaks as a whole, and is made into the field configuration while it has formed 1h of triangle pole-like hollows in the center section of plane core cut section 1e. In addition, as for this sloping flat surface, the inclination is set up so that 1h [ of triangle pole-like hollows ] distance Wy'' may become equal to distance Wy' with a non-inclining flat surface in plane core cut section 1e and 1f \*\*\*\* configuration.

[0059] Therefore, also when this embodiment is adopted, while being able to make reduction of slot area into the minimum and being able to control the increment in copper loss, iron loss can also be reduced by easing magnetic-flux concentration and preventing the rise of flux density. Consequently, reduction of ingredient cost and improvement in handling nature can be attained by forming a core cut, and also it is compatible in the reduction in the noise, and efficient-ization.

[0060] Drawing 12 is the sectional view expanding and showing the important section of the embodiment of

further others of SR motor of this invention.

[0061] By making the predetermined range which follows tooth part 1b instead of a mere flat-surface configuration in the \*\*\*\* configuration of 1f into the flat surface which inclined in the inner sense, this SR motor breaks as a whole, and is made into the field configuration while it makes the center section of plane core cut section 1e correspond and has formed through tube 1i. In addition, as for this sloping flat surface, the inclination is set up so that distance Wy'' with through tube 1i may become equal to distance Wy' with a non-inclining flat surface in plane core cut section 1e and 1f \*\*\*\* configuration.

[0062] Therefore, also when this embodiment is adopted, while being able to make reduction of slot area into the minimum and being able to control the increment in copper loss, iron loss can also be reduced by easing magnetic-flux concentration and preventing the rise of flux density. Consequently, reduction of ingredient cost and improvement in handling nature can be attained by forming a core cut, and also it is compatible in the reduction in the noise, and efficient-ization.

[0063] Drawing 13 is the sectional view expanding and showing the important section of the embodiment of further others of SR motor of this invention.

[0064] This SR motor is replaced with a \*\*\*\* configuration, and is set to R configuration 1j of the large radius of curvature on the basis of the predetermined location close to the protrusion point of tooth part 1b while it has formed plane core cut section 1e. In addition, radius of curvature and said origin are set up so that this R configuration may become equal to the back yoke width of face [ in / in distance Wy' with core cut section 1e / the non-core cut section ] Wy.

[0065] Therefore, also when this embodiment is adopted, while being able to make reduction of slot area into the minimum and being able to control the increment in copper loss, iron loss can also be reduced by easing magnetic-flux concentration and preventing the rise of flux density. However, since slot area becomes small rather than the case where the \*\*\*\* configuration shown in drawing 7 is adopted, copper loss increases from the case where the embodiment of drawing 7 is adopted. However, since a back yoke spreads equivalent, the noise-reduction effectiveness improves. That is, when making degradation into the minimum by the motor of rigid serious consideration, it can adopt.

[0066] Drawing 14 is the sectional view expanding and showing the important section of the embodiment of further others of SR motor of this invention.

[0067] This SR motor has made the \*\*\*\* configuration of 1f the mere flat-surface configuration while having formed plane core cut section 1e in the predetermined range which follows the part which carries out a right pair to tooth part 1b. In addition, this \*\*\*\* configuration of 1f is set up so that distance Wy' with core cut section 1e may become equal to the back yoke width of face Wy in the non-core cut section.

[0068] Therefore, also when this embodiment is adopted, while being able to make reduction of slot area into the minimum and being able to control the increment in copper loss, iron loss can also be reduced by easing magnetic-flux concentration and preventing the rise of flux density. Consequently, by forming a core cut, oil tempering can be carried out, and reservation of a path and improvement in handling nature can be attained, and also it is compatible in the reduction in the noise, and efficient-ization.

[0069] Drawing 15 is the sectional view expanding and showing the important section of the embodiment of further others of SR motor of this invention.

[0070] The point that this SR motor differs from SR motor of drawing 7 is only a point of having omitted the core cut.

[0071] Therefore, since the thickness of back yoke section 1a becomes larger than the back yoke width of face corresponding to the non-\*\*\*\* configuration section in the part corresponding to 1f of \*\*\*\* configuration sections when this embodiment is adopted, rigidity can be raised. However, since slot area decreases in connection with forming 1f of \*\*\*\* configuration sections, some motor efficiencies fall. If it puts in another way, it can apply, when making degradation into the minimum in SR motor of rigid serious consideration.

[0072] Drawing 16 is the sectional view expanding and showing the important section of the embodiment of further others of SR motor of this invention.

[0073] The point that this SR motor differs from SR motor of drawing 10 is only a point which adopted the configuration which consists only of a flat surface which inclined in the inner sense as the point which omitted the core cut and formed only 1g of hollows of a semicircle column configuration, and a \*\*\*\* configuration of 1f.

[0074] Therefore, also when this embodiment is adopted, while being able to make reduction of slot area into the minimum and being able to control the increment in copper loss, iron loss can also be reduced by easing magnetic-flux concentration and preventing the rise of flux density. However, since slot area becomes small rather than the case where the \*\*\*\* configuration shown in drawing 7 is adopted, copper loss increases from the case where the embodiment of drawing 7 is adopted. However, since a back yoke spreads equivalent, the noise-reduction effectiveness improves. That is, when making degradation into the minimum by the motor of rigid serious consideration, it can adopt.

[0075] Drawing 17 is the sectional view expanding and showing the important section of the embodiment of

further others of SR motor of this invention.

[0076] The point that this SR motor differs from SR motor of drawing 11 is only a point which adopted the configuration which consists only of a flat surface which inclined in the inner sense as the point which omitted the core cut and formed only 1h of triangle-like hollows, and a \*\*\*\* configuration of 1f.

[0077] Therefore, also when this embodiment is adopted, while being able to make reduction of slot area into the minimum and being able to control the increment in copper loss, iron loss can also be reduced by easing magnetic-flux concentration and preventing the rise of flux density. However, since slot area becomes small rather than the case where the \*\*\*\* configuration shown in drawing 7 is adopted, copper loss increases from the case where the embodiment of drawing 7 is adopted. However, since a back yoke spreads equivalent, the noise-reduction effectiveness improves. That is, when making degradation into the minimum by the motor of rigid serious consideration, it can adopt.

[0078] Drawing 18 is the sectional view expanding and showing the important section of the embodiment of further others of SR motor of this invention.

[0079] The point that this SR motor differs from SR motor of drawing 12 is only a point which adopted the configuration which consists only of a flat surface which inclined in the inner sense as the point which omitted the core cut and formed only through tube 1i, and a \*\*\*\* configuration of 1f.

[0080] Therefore, also when this embodiment is adopted, while being able to make reduction of slot area into the minimum and being able to control the increment in copper loss, iron loss can also be reduced by easing magnetic-flux concentration and preventing the rise of flux density. Consequently, direct immobilization of the stator by the bolt or the pin can be attained by forming a through tube, and also it is compatible in the reduction in the noise, and efficient-ization.

[0081] Drawing 19 is the sectional view expanding and showing the important section of the embodiment of further others of SR motor of this invention.

[0082] The point that this SR motor differs from SR motor of drawing 4 is only a point in which hollow 1k of many rectangles was formed on the external surface of back yoke section 1a.

[0083] Therefore, when this embodiment is adopted, improvement in heat dissipation nature and handling nature can be attained, and also it is compatible in the reduction in the noise, and efficient-ization.

[0084]

[Effect of the Invention] Invention of claim 1 does so the characteristic effectiveness that reduction and efficient-izing of the noise can be reconciled.

[0085] Invention of claim 2 does so the characteristic effectiveness that reduction and efficient-izing of the noise can be reconciled.

[0086] Since invention of claim 3 does not need to use what in addition to the effectiveness of claim 2 low copper loss-ization can be attained, and generation of heat by the stator winding can be reduced, as a result is borne to high temperature as an insulating material of SR motor, it does so the characteristic effectiveness that a cheap insulating material can be used.

[0087] In addition to the effectiveness of claim 2, invention of claim 4 attains low iron loss-ization and does so the characteristic effectiveness that the magnetic steel sheet which consists of a cheap steel plate ingredient is employable.

[0088] Invention of claim 5 can attain reduction of ingredient cost, and improvement in handling nature, and also does so the same effectiveness as any of claim 1 to claim 4. they are.

---

[Translation done.]

**\* NOTICES \***

JPO and NCIP are not responsible for any damages caused by the use of this translation.

1. This document has been translated by computer. So the translation may not reflect the original precisely.
2. \*\*\*\* shows the word which can not be translated.
3. In the drawings, any words are not translated.

---

**TECHNICAL FIELD**

---

[Field of the Invention] This invention relates to new SR motor compatible in the low noise and a well head, if it says further a detail about a switch TORIRAKU wardrobe motor (SR motor is called hereafter).

---

[Translation done.]

**\* NOTICES \***

JP0 and NCIP1 are not responsible for any damages caused by the use of this translation.

- 1.This document has been translated by computer. So the translation may not reflect the original precisely.
- 2.\*\*\*\* shows the word which can not be translated.
- 3.In the drawings, any words are not translated.

---

**PRIOR ART**

---

[Description of the Prior Art] SR motor is a motor which generates torque, when the magnetic flux passing through the magnetic circuit formed as each stator winding by which the concentration volume was carried out to the slot of a stator was excited discretely and it was shown in drawing 23 changes.

[0003] here, since magnetic flux  $\phi_0$  generated in the tooth part (refer to A in drawing 23) is made right and left in the back yoke section for 2 minutes, if the thickness (width of face)  $W_y$  of the back yoke section shown in drawing 24 is set or more [ of the width of face  $W_t$  of a tooth part ] to  $1/2$ , it can pass smoothly the magnetic flux  $\phi_0$  generated in the tooth part, without carrying out magnetic saturation in the back yoke section namely..

[0004] If this configuration is adopted, the back yoke section is saturated ahead of a tooth part, there is no un-arranging [ that torque decreases ], slot area becomes max, reduction of the coil resistance by the increment in the amount of coils can be attained, and copper loss is made to min, as a result efficient-ization of SR motor can be attained.

[0005] However, when SR motor was made as an experiment as mentioned above, compared with the conventional motor (an induction motor, brushless DC motor) of the same output, it turned out that about 10dB or more and the motor simple substance noise become large. This originates in the motor and drive method of others [ motor / SR ] differing from each other. the drive wave of SR motor, and electromagnetism -- relation with a suction force is shown in drawing 26. the lap of the salient pole section of a stator and a rotator becomes large -- following -- electromagnetism -- the place with which the suction force increased and the salient pole sections of a stator and a rotator lapped -- electromagnetism -- a suction force serves as max. this electromagnetism -- deformation (ellipse deformation) of the direction of a path is caused to a stator by the suction force. Since the location of this ellipse deformation changes whenever an excitation phase switches, it is operated repeating concavo-convex movement and a stator generates the noise. this was pointed out from the former as a trouble of SR motor proper -- it is inconvenient.

[0006] the approach (refer to JP,9-294359,A, JP,9-103055,A, JP,9-103056,A, and JP,2-119561,A) of performing (1) buffer and reinforcement as an approach proposed in order to make it canceling this to un-arrange and (2) -- electromagnetism -- the approach (refer to JP,9-331663,A) of reducing a suction force, the method (refer to U.S. Pat. No. 5266859 specification) of putting in (3) skews, and the approach (refer to JP,3-159531,A) of raising (4) rigidity are proposed. [ and ]

---

[Translation done.]

**\* NOTICES \***

JPO and NGIPI are not responsible for any damages caused by the use of this translation.

- 1.This document has been translated by computer. So the translation may not reflect the original precisely.
- 2.\*\*\*\* shows the word which can not be translated.
- 3.In the drawings, any words are not translated.

---

**EFFECT OF THE INVENTION**

---

[Effect of the Invention] Invention of claim 1 does so the characteristic effectiveness that reduction and efficient-izing of the noise can be reconciled.

[0085] Invention of claim 2 does so the characteristic effectiveness that reduction and efficient-izing of the noise can be reconciled.

[0086] Since invention of claim 3 does not need to use what in addition to the effectiveness of claim 2 low copper loss-ization can be attained, and generation of heat by the stator winding can be reduced, as a result is borne to high temperature as an insulating material of SR motor, it does so the characteristic effectiveness that a cheap insulating material can be used.

[0087] In addition to the effectiveness of claim 2, invention of claim 4 attains low iron loss-ization and does so the characteristic effectiveness that the magnetic steel sheet which consists of a cheap steel plate ingredient is employable.

[0088] Invention of claim 5 can attain reduction of ingredient cost, and improvement in handling nature, and also does so the same effectiveness as any of claim 1 to claim 4 they are.

---

[Translation done.]

\* NOTICES \*

JPO and NCIP are not responsible for any damages caused by the use of this translation.

1. This document has been translated by computer. So the translation may not reflect the original precisely.
2. \*\*\*\* shows the word which can not be translated.
3. In the drawings, any words are not translated.

---

TECHNICAL PROBLEM

---

[Problem(s) to be Solved by the Invention] Since shock absorbing material and reinforcing materials are needed in adopting the approach of the above (1), it not only causes the cost rise accompanying adopting these, but it will cause the increment in the man day for incorporating these.

[0008] the case where the approach of the above (2) is adopted -- electromagnetism -- there is un-arranging [ that generating torque will fall with the fall of a suction force ].

[0009] the electromagnetism which works between the stators and rotators which cause above (3) the ellipse deformation to which the noise of SR motor is made to increase -- although it is what distributes a suction force by the skew -- electromagnetism -- since it does not contribute to raising the rigidity of a motor at all so that clearly from the torque fall by distribution of a suction force, and a formula (1), it is thought that the noise in the resonant frequency of a motor cannot be reduced.

[0010] In adopting the approach of the above (4), there is un-arranging [ that effectiveness falls with the increment in back yoke width of face ].

[0011] The approach of the above (4) is explained further.

[0012] Generally, the noise can be reduced if the rigidity of a motor is raised. This is shown by reference "Vibration Modes and Acoustic Noise in a Fore-Phase Switched Reluctance Motor" (IEEE TRANSACTIONS ON INDUSTRY, VOL.32, NOVEMBER/DECEMBER 1996). Specifically, the degree type showing the resonance angular frequency  $\omega$  is shown. For  $\omega^2 = (2 \times 1.04452 / 1.625\pi) \times (E/\rho) \times (t^2/R^4)$ , however  $E$ , Young's modulus and  $\rho$  are [ back yoke width of face and  $R$  of an ingredient consistency and  $t$  ] ring radii.

[0013] As shown in an upper type, in order to raise rigidity, without changing a motor outer diameter, it is needed to make back yoke width of face increase. However, if back yoke width of face is made to only increase as shown in drawing 27, slot area will decrease, the amount of coil wearing will decrease, and coil resistance will increase (it is an invitation about the increment in copper loss), as a result a motor efficiency will be reduced.

[0014] In addition, since thickness radial [ in the field of a height ] increases as one of the effectiveness by preparing a triangular projection between slots, JP,3-159531,A can raise rigidity, can fall the noise, but since slot area decreases as shown in drawing 28, and copper loss increases, it cannot avoid decline in effectiveness.

[0015] A noise reduction sake, Said reference "Vibration Modes and Acoustic Noise in a Fore-Phase Switched Reluctance It is based on the idea of Motor" (IEEE TRANSACTIONS ON INDUSTRY, VOL.32, NOVEMBER/DECEMBER 1996). Although the noise was able to carry out about 10 dBA reduction when the thickness  $W_y$  of the York section was set up so that it might become twice the width of face  $W_t$  of a tooth part and SR motor was made as an experiment, as shown in drawing 25, by having expanded back yoke width of face, slot area became small, copper loss increased, and effectiveness has fallen.

[0016] it had been thought like an approach since each \*\* of a more than that the coexistence with reduction of the noise and efficient-izing was impossible.

[0017]

[Objects of the Invention] This invention is made in view of the above-mentioned trouble, and it aims at offering SR motor which can reconcile reduction and efficient-izing of the noise.

---

[Translation done.]

**\* NOTICES \***

JPO and NGIPI are not responsible for any damages caused by the use of this translation.

1. This document has been translated by computer. So the translation may not reflect the original precisely.
2. \*\*\*\* shows the word which can not be translated.
3. In the drawings, any words are not translated.

---

**MEANS**

---

[Means for Solving the Problem] While SR motor of claim 1 is winding the stator winding around the slot which prepares the tooth part which projects in the inside sense for every predetermined spacing in the inside of a stator, and is specified inside by the tooth part, inside a stator the thing which comes to prepare the rotator which has the tooth part which projects outward for every predetermined spacing in the external surface of a rotator -- it is -- the ratio of the width of face Wt of the tooth part of a stator, and the back yoke width of face Wy --  $Wy/Wt$  is set as the predetermined value which can attain efficient-izing and low noise-ization.

[0019] SR motor of claim 2 -- the ratio of the width of face Wt of the tooth part of a stator, and the back yoke width of face Wy --  $Wy/Wt$  is set to 0.8 or more and 1.4 or less.

[0020] SR motor of claim 3 sets aforementioned ratio  $Wy/Wt$  to 0.8 or more and 1.0 or less.

[0021] SR motor of claim 4 sets aforementioned ratio  $Wy/Wt$  to 1.0 or more and 1.4 or less.

[0022] SR motor of claim 5 is made to correspond to the base of a tooth part, and forms the flat-surface section that reduction of the width of face Wy of a back yoke should be compensated while it has formed the plane core cut in the external surface of the back yoke corresponding to the tooth part of a stator.

---

[Translation done.]

**\* NOTICES \***

JPO and NCIPJ are not responsible for any damages caused by the use of this translation.

1. This document has been translated by computer. So the translation may not reflect the original precisely.
2. \*\*\*\* shows the word which can not be translated.
3. In the drawings, any words are not translated.

---

**OPERATION**

---

[Function] If it is SR motor of claim 1, while winding the stator winding around the slot which prepares the tooth part which projects in the inside sense for every predetermined spacing in the inside of a stator, and is specified inside by the tooth part It is the thing which comes to prepare a rotator with the tooth part which projects outward for every predetermined spacing on the external surface of a rotator in the interior of a stator. the ratio of the width of face  $W_t$  of the tooth part of a stator, and the back yoke width of face  $W_y$  -- since  $W_y/W_t$  was set as the predetermined value which can attain efficient-izing and low noise-ization, reduction and efficient-izing of the noise can be reconciled.

[0024] SR motor of claim 2 -- the ratio of the width of face  $W_t$  of the tooth part of a stator, and the back yoke width of face  $W_y$  -- since  $W_y/W_t$  was set to 0.8 or more and 1.4 or less, reduction and efficient-izing of the noise can be reconciled.

[0025] Furthermore, it explains.

[0026] the ratio of the width of face  $W_t$  of the tooth part of a stator, and the back yoke width of face  $W_y$  -- the relation between  $\alpha = W_y/W_t$  and electric loss (= iron loss + copper loss) of SR motor is given as shown in drawing 20 . and this relation shows -- as -- a ratio -- in order that slot area may decrease with the increment in  $\alpha$  -- copper loss -- a ratio -- it increases with the increment in  $\alpha$ . on the other hand -- iron loss -- a ratio -- until  $\alpha$  is set to 1.4 -- a ratio -- although it decreases in monotone with the increment in  $\alpha$  -- a ratio -- even if  $\alpha$  exceeds 1.4, iron loss does not decrease any more. this -- a ratio -- drawing 21 which shows change of the flux density accompanying change of  $\alpha$  shows -- as -- a ratio -- if  $\alpha$  becomes 1.4 or more, change of the flux density of the back yoke section will become loose, and it is thought that it is because iron loss is generally proportional to the square of flux density.

[0027] moreover, drawing 20 shows -- as -- a ratio --  $\alpha$  -- the range of 0.4 or more and 1.4 -- electric loss of SR motor -- small -- further -- a ratio -- when  $\alpha$  is before and after one, electric loss of SR motor serves as the minimal value.

[0028] furthermore, a ratio -- drawing 22 which shows change of the noise of SR motor accompanying change of  $\alpha$  shows -- as -- a ratio, although the noise-reduction effectiveness of 7 or more dBAs can be acquired by making  $\alpha$  or more into 0.8 a ratio -- since slot area decreases in electric loss of a motor so that  $\alpha$  may be understood from drawing 20 in spite of there being little noise-reduction effectiveness also as 1.4 or more (2 - 3dBA extent), and copper loss increases, loss will increase.

[0029] therefore, a ratio -- the low noise and efficient-ization can be reconciled by setting  $\alpha$  to 0.8 or more and 1.4 or less as mentioned above.

[0030] If it is SR motor of claim 3, since aforementioned ratio  $W_y/W_t$  was set to 0.8 or more and 1.0 or less and it is not necessary to use what low copper loss-ization can be attained, and generation of heat by the stator winding can be reduced in this case, as a result is borne to high temperature as an insulating material of SR motor, a cheap insulating material can be used.

[0031] If it is SR motor of claim 4, since aforementioned ratio  $W_y/W_t$  was set to 1.0 or more and 1.4 or less, low iron loss-ization can be attained and the magnetic steel sheet which consists of a cheap steel plate ingredient in this case can be adopted.

[0032] If it is SR motor of claim 5, while having formed the plane core cut in the external surface of the back yoke corresponding to the tooth part of a stator, that it should be made to correspond to the base of a tooth part, and reduction of the width of face  $W_y$  of a back yoke should be compensated, since the flat-surface section was formed, reduction of ingredient cost and improvement in handling nature can be attained, and also the same operation as any of claim 1 to claim 4 they are can be attained.

[0033]

[Embodiment of the Invention] Hereafter, with reference to an accompanying drawing, the mode of operation of SR motor of this invention is explained to a detail.

[0034] Drawing 1 is the sectional view of SR motor of this invention showing a configuration [ like ] roughly 1 operative condition.

[0035] While this SR motor is a 6 pole type thing and really coming to form tooth part 1b of the sense among six

at equal intervals to cylinder-like back yoke section 1a It has the rotator 2 which really comes to form four outward tooth part 2bs at equal intervals to the stator 1 which comes to wind a stator winding (not shown) around slot section 1c formed by two tooth part 1b which adjoins back yoke section 1a, and cylinder-like body section 2a.

[0036] However, it is possible to adopt a 12 pole type configuration, as shown in drawing 2 , to adopt a 8 pole type configuration, as shown in drawing 3 , etc.

[0037] and the case where width of face (face width) of Wy and a tooth part is set to Wt for the thickness (back yoke width of face) of back yoke section 1a -- the ratio of the back yoke width of face Wy and a face width Wt --  $\alpha (= Wy/Wt)$  is set to 0.8 or more and 1.4 or less.

[0038] If this configuration is adopted, reduction of slot area can be made into the minimum and the increment in copper loss can be made into necessary minimum. Magnetic-flux concentration is eased, the rise of flux density can be prevented to coincidence, iron loss can be reduced to it, and electric loss of a motor is not made to increase to it. Furthermore, as shown in drawing 2222 , the noise can be reduced by 7 or more dBAs. Therefore, the reduction in the noise and efficient-ization can be reconciled, without [ without it uses shock absorbing material and reinforcing materials leading to a cost rise, and ] reducing torque.

[0039] If the aforementioned ratio  $\alpha$  is especially set to 0.8 or more and 1.0 or less, since low copper loss-ization can be attained and it is not necessary to use what generation of heat by the stator winding can be small carried out, as a result is borne to high temperature as an insulating material, a cheap insulating material can be used. On the contrary, if the aforementioned ratio  $\alpha$  is set to 1.0 or more and 1.4 or less, since low iron loss-ization can be attained, the magnetic steel sheet which consists of a cheap steel plate ingredient is employable.

[0040] In addition, also in each following embodiment, the aforementioned ratio  $\alpha$  is set to 0.8 or more and 1.4 or less. In addition, the above-mentioned knowledge can be concerned the different dental shape of a number or an appearance, and can be applied that there is nothing. Although various embodiments are shown below, in any case, the aforementioned ratio  $\alpha$  is set up 0.8 or more and 1.4 or less.

[0041] Drawing 4 is the sectional view showing roughly the configuration of other embodiments of SR motor of this invention. In addition, the rotator has omitted illustration.

[0042] The point that this SR motor differs from SR motor of drawing 1 is only a point which made the rectangle the appearance of back yoke section 1a.

[0043] In this embodiment, although the thickness of back yoke section 1a changes with locations, the smallest thickness is adopted as back yoke width of face Wy. Moreover, 1d of through tubes is formed in four corners of back yoke section 1a.

[0044] In addition, it is possible also in the case of this embodiment, to adopt a 12 pole type configuration, as shown in drawing 5 , to adopt a 8 pole type configuration, as shown in drawing 6 , etc.

[0045] Drawing 7 is the sectional view expanding and showing the important section of the embodiment of further others of SR motor of this invention.

[0046] While this SR motor has given plane core cut 1e to the external surface of back yoke section 1a corresponding to tooth part 1b 1f (plane \*\*\*\* configuration) of flat-surface sections is formed instead of forming a hollow (R section) that reduction of the back yoke width of face by core cut should be compensated, as it is made to correspond to the base of tooth part 1b and a slash shows in drawing 7 . It is made equal to the back yoke width of face [ in / for distance Wy' with 1f of this flat-surface section, and core cut section 1e / the non-core cut section ] Wy.

[0047] If this configuration is adopted, reduction of ingredient cost and improvement in handling nature can be attained by forming a core cut, and also it is compatible in the reduction in the noise, and efficient-ization.

[0048] Furthermore, it explains.

[0049] As shown in drawing 8 , when a plane core cut is performed in the conventional SR motor, the distance Wy1 between the hollows (R section) and the core cut sections in the base of a tooth part is smaller than the back yoke width of face Wy in the non-core cut section.

[0050] And since back yoke width of face serves as Wy1 instead of Wy, magnetic flux is regulated between a hollow and the core cut section, and concentration of magnetic flux produces it. Consequently, iron loss increases and a motor efficiency falls. Moreover, since the thickness of the back yoke section is thin between a hollow and the core cut section, rigidity becomes weak and the noise and vibration increase.

[0051] Moreover, in order to cancel above un-arranging, as shown in drawing 9 R> 9, it can consider making the thickness of back yoke section 1a increase inside so that the distance between the core cut sections may serve as Wy, but in this case, since slot area decreases (the percentage reduction of slot area is about 22%), copper loss will increase and a motor efficiency will fall.

[0052] On the other hand, if the configuration of drawing 7 is adopted, since the percentage reduction of slot area is about 7%, reduction of slot area can be made into the minimum and the increment in copper loss can be controlled. Moreover, since magnetic-flux concentration is eased and the rise of flux density is prevented, iron loss can also be reduced. Consequently, if the increment in copper loss and reduction of iron loss are

synthesized and evaluated, the decline in a motor efficiency will not be accepted as compared with the case where there is no core cut.

[0053] Moreover, since the \*\*\*\* configuration shown in drawing 7 is in the relation between a tooth part and a right angle, the alignment volume of a stator winding tends to carry out it, its space factor improves, since the slot bottom section is a straight line, and it can enlarge the amount of coil wearing, it can be contributed to reduction in resistance, and reduction of copper loss.

[0054] Drawing 10 is the sectional view expanding and showing the important section of the embodiment of further others of SR motor of this invention.

[0055] By making the predetermined range which follows tooth part 1b instead of a mere flat-surface configuration in the \*\*\*\* configuration of 1f into the flat surface which inclined in the inner sense, this SR motor breaks as a whole, and is made into the field configuration while it has formed 1g of semicircle column-like hollows in the center section of plane core cut section 1e. In addition, as for this sloping flat surface, the inclination is set up so that 1g [ of semicircle column-like hollows ] distance Wy'' may become equal to distance Wy' with a non-inclining flat surface among the plane core cut section and a \*\*\*\* configuration.

[0056] Therefore, also when this embodiment is adopted, while being able to make reduction of slot area into the minimum and being able to control the increment in copper loss, iron loss can also be reduced by easing magnetic-flux concentration and preventing the rise of flux density. Consequently, reduction of ingredient cost and improvement in handling nature can be attained by forming a core cut, and also it is compatible in the reduction in the noise, and efficient-ization.

[0057] Drawing 11 is the sectional view expanding and showing the important section of the embodiment of further others of SR motor of this invention.

[0058] By making the predetermined range which follows tooth part 1b instead of a mere flat-surface configuration in the \*\*\*\* configuration of 1f into the flat surface which inclined in the inner sense, this SR motor breaks as a whole, and is made into the field configuration while it has formed 1h of triangle pole-like hollows in the center section of plane core cut section 1e. In addition, as for this sloping flat surface, the inclination is set up so that 1h [ of triangle pole-like hollows ] distance Wy'' may become equal to distance Wy' with a non-inclining flat surface in plane core cut section 1e and 1f \*\*\*\* configuration.

[0059] Therefore, also when this embodiment is adopted, while being able to make reduction of slot area into the minimum and being able to control the increment in copper loss, iron loss can also be reduced by easing magnetic-flux concentration and preventing the rise of flux density. Consequently, reduction of ingredient cost and improvement in handling nature can be attained by forming a core cut, and also it is compatible in the reduction in the noise, and efficient-ization.

[0060] Drawing 12 is the sectional view expanding and showing the important section of the embodiment of further others of SR motor of this invention.

[0061] By making the predetermined range which follows tooth part 1b instead of a mere flat-surface configuration in the \*\*\*\* configuration of 1f into the flat surface which inclined in the inner sense, this SR motor breaks as a whole, and is made into the field configuration while it makes the center section of plane core cut section 1e correspond and has formed through tube 1i. In addition, as for this sloping flat surface, the inclination is set up so that distance Wy'' with through tube 1i may become equal to distance Wy' with a non-inclining flat surface in plane core cut section 1e and 1f \*\*\*\* configuration.

[0062] Therefore, also when this embodiment is adopted, while being able to make reduction of slot area into the minimum and being able to control the increment in copper loss, iron loss can also be reduced by easing magnetic-flux concentration and preventing the rise of flux density. Consequently, reduction of ingredient cost and improvement in handling nature can be attained by forming a core cut, and also it is compatible in the reduction in the noise, and efficient-ization.

[0063] Drawing 13 is the sectional view expanding and showing the important section of the embodiment of further others of SR motor of this invention.

[0064] This SR motor is replaced with a \*\*\*\* configuration, and is set to R configuration 1j of the large radius of curvature on the basis of the predetermined location close to the protrusion point of tooth part 1b while it has formed plane core cut section 1e. In addition, radius of curvature and said origin are set up so that this R configuration may become equal to the back yoke width of face [ in / in distance Wy' with core cut section 1e / the non-core cut section ] Wy.

[0065] Therefore, also when this embodiment is adopted, while being able to make reduction of slot area into the minimum and being able to control the increment in copper loss, iron loss can also be reduced by easing magnetic-flux concentration and preventing the rise of flux density. However, since slot area becomes small rather than the case where the \*\*\*\* configuration shown in drawing 7 is adopted, copper loss increases from the case where the embodiment of drawing 7 is adopted. However, since a back yoke spreads equivalent, the noise-reduction effectiveness improves. That is, when making degradation into the minimum by the motor of rigid serious consideration, it can adopt.

[0066] Drawing 14 is the sectional view expanding and showing the important section of the embodiment of further others of SR motor of this invention.

[0067] This SR motor has made the \*\*\*\* configuration of 1f the mere flat-surface configuration while having formed plane core cut section 1e in the predetermined range which follows the part which carries out a right pair to tooth part 1b. In addition, this \*\*\*\* configuration of 1f is set up so that distance Wy' with core cut section 1e may become equal to the back yoke width of face Wy in the non-core cut section.

[0068] Therefore, also when this embodiment is adopted, while being able to make reduction of slot area into the minimum and being able to control the increment in copper loss, iron loss can also be reduced by easing magnetic-flux concentration and preventing the rise of flux density. Consequently, by forming a core cut, oil tempering can be carried out, and reservation of a path and improvement in handling nature can be attained, and also it is compatible in the reduction in the noise, and efficient-ization.

[0069] Drawing 15 is the sectional view expanding and showing the important section of the embodiment of further others of SR motor of this invention.

[0070] The point that this SR motor differs from SR motor of drawing 7 is only a point of having omitted the core cut.

[0071] Therefore, since the thickness of back yoke section 1a becomes larger than the back yoke width of face corresponding to the non-\*\*\*\* configuration section in the part corresponding to 1f of \*\*\*\* configuration sections when this embodiment is adopted, rigidity can be raised. However, since slot area decreases in connection with forming 1f of \*\*\*\* configuration sections, some motor efficiencies fall. If it puts in another way, it can apply, when making degradation into the minimum in SR motor of rigid serious consideration.

[0072] Drawing 16 is the sectional view expanding and showing the important section of the embodiment of further others of SR motor of this invention.

[0073] The point that this SR motor differs from SR motor of drawing 10 is only a point which adopted the configuration which consists only of a flat surface which inclined in the inner sense as the point which omitted the core cut and formed only 1g of hollows of a semicircle column configuration, and a \*\*\*\* configuration of 1f.

[0074] Therefore, also when this embodiment is adopted, while being able to make reduction of slot area into the minimum and being able to control the increment in copper loss, iron loss can also be reduced by easing magnetic-flux concentration and preventing the rise of flux density. However, since slot area becomes small rather than the case where the \*\*\*\* configuration shown in drawing 7 is adopted, copper loss increases from the case where the embodiment of drawing 7 is adopted. However, since a back yoke spreads equivalent, the noise-reduction effectiveness improves. That is, when making degradation into the minimum by the motor of rigid serious consideration, it can adopt.

[0075] Drawing 17 is the sectional view expanding and showing the important section of the embodiment of further others of SR motor of this invention.

[0076] The point that this SR motor differs from SR motor of drawing 11 is only a point which adopted the configuration which consists only of a flat surface which inclined in the inner sense as the point which omitted the core cut and formed only 1h of triangle-like hollows, and a \*\*\*\* configuration of 1f.

[0077] Therefore, also when this embodiment is adopted, while being able to make reduction of slot area into the minimum and being able to control the increment in copper loss, iron loss can also be reduced by easing magnetic-flux concentration and preventing the rise of flux density. However, since slot area becomes small rather than the case where the \*\*\*\* configuration shown in drawing 7 is adopted, copper loss increases from the case where the embodiment of drawing 7 is adopted. However, since a back yoke spreads equivalent, the noise-reduction effectiveness improves. That is, when making degradation into the minimum by the motor of rigid serious consideration, it can adopt.

[0078] Drawing 18 is the sectional view expanding and showing the important section of the embodiment of further others of SR motor of this invention.

[0079] The point that this SR motor differs from SR motor of drawing 12 is only a point which adopted the configuration which consists only of a flat surface which inclined in the inner sense as the point which omitted the core cut and formed only through tube 1i, and a \*\*\*\* configuration of 1f.

[0080] Therefore, also when this embodiment is adopted, while being able to make reduction of slot area into the minimum and being able to control the increment in copper loss, iron loss can also be reduced by easing magnetic-flux concentration and preventing the rise of flux density. Consequently, direct immobilization of the stator by the bolt or the pin can be attained by forming a through tube, and also it is compatible in the reduction in the noise, and efficient-ization.

[0081] Drawing 19 is the sectional view expanding and showing the important section of the embodiment of further others of SR motor of this invention.

[0082] The point that this SR motor differs from SR motor of drawing 4 is only a point in which hollow 1k of many rectangles was formed on the external surface of back yoke section 1a.

[0083] Therefore, when this embodiment is adopted, improvement in heat dissipation nature and handling nature

can be attained, and also it is compatible in the reduction in the noise, and efficient-ization.

---

[Translation done.]

## \* NOTICES \*

JPO and NCIP are not responsible for any damages caused by the use of this translation.

1. This document has been translated by computer. So the translation may not reflect the original precisely.
2. \*\*\*\* shows the word which can not be translated.
3. In the drawings, any words are not translated.

---

## DESCRIPTION OF DRAWINGS

---

### [Brief Description of the Drawings]

[Drawing 1] It is the sectional view of SR motor of this invention showing a configuration [ like ] roughly 1 operative condition.

[Drawing 2] It is the sectional view showing a modification roughly.

[Drawing 3] It is the sectional view showing other modifications roughly.

[Drawing 4] It is the sectional view showing roughly the configuration of other embodiments of SR motor of this invention.

[Drawing 5] It is the sectional view showing a modification roughly.

[Drawing 6] It is the sectional view showing other modifications roughly.

[Drawing 7] It is the sectional view showing roughly the important section of the embodiment of further others of SR motor of this invention.

[Drawing 8] It is the sectional view showing roughly the configuration to which the conventional SR motor corresponds.

[Drawing 9] It is the sectional view showing the development form of SR motor of drawing 8 roughly.

[Drawing 10] It is the sectional view showing roughly the important section of the embodiment of further others of SR motor of this invention.

[Drawing 11] It is the sectional view showing roughly the important section of the embodiment of further others of SR motor of this invention.

[Drawing 12] It is the sectional view showing roughly the important section of the embodiment of further others of SR motor of this invention.

[Drawing 13] It is the sectional view showing roughly the important section of the embodiment of further others of SR motor of this invention.

[Drawing 14] It is the sectional view showing roughly the important section of the embodiment of further others of SR motor of this invention.

[Drawing 15] It is the sectional view showing roughly the important section of the embodiment of further others of SR motor of this invention.

[Drawing 16] It is the sectional view showing roughly the important section of the embodiment of further others of SR motor of this invention.

[Drawing 17] It is the sectional view showing roughly the important section of the embodiment of further others of SR motor of this invention.

[Drawing 18] It is the sectional view showing roughly the important section of the embodiment of further others of SR motor of this invention.

[Drawing 19] It is the sectional view showing roughly the important section of the embodiment of further others of SR motor of this invention.

[Drawing 20] It is drawing explaining change of electric loss of SR motor accompanying change which is Ratio  $\alpha$ .

[Drawing 21] It is drawing explaining change of the flux density of the back yoke section accompanying change which is Ratio  $\alpha$ .

[Drawing 22] It is drawing explaining change of the noise accompanying change which is Ratio  $\alpha$ .

[Drawing 23] It is a schematic diagram explaining the principle of operation of SR motor.

[Drawing 24] It is the sectional view showing an example of the configuration of the conventional SR motor roughly.

[Drawing 25] It is the sectional view showing other examples of the configuration of the conventional SR motor roughly.

[Drawing 26] the drive wave of SR motor, and electromagnetism -- it is drawing showing relation with a suction force, and ellipse deformation of a stator.

[Drawing 27] It is drawing explaining reduction of the slot area accompanying making the width of face of a back yoke increase.

[Drawing 28] It is drawing explaining reduction of the slot area accompanying preparing a triangular projection between slots.

[Description of Notations]

1 Stator 1B Tooth Part

1c Slot 1e Core cut

1f Flat-surface section 2 Rotator

---

[Translation done.]

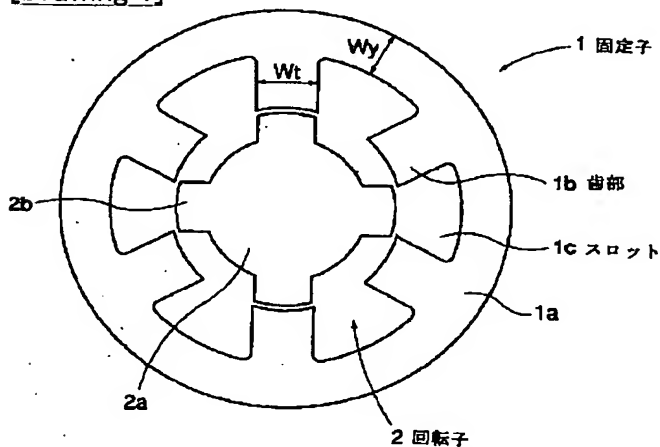
**\* NOTICES \***

JPO and NCIP are not responsible for any damages caused by the use of this translation.

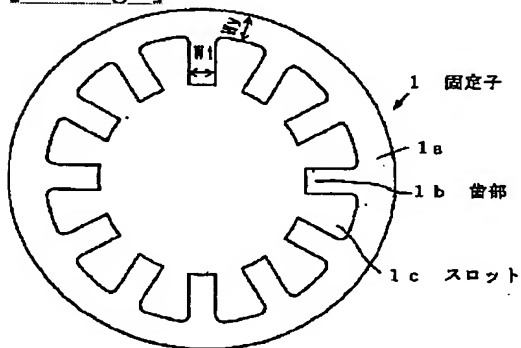
- 1.This document has been translated by computer. So the translation may not reflect the original precisely.  
2.\*\*\*\* shows the word which can not be translated.  
3.In the drawings, any words are not translated.

## DRAWINGS

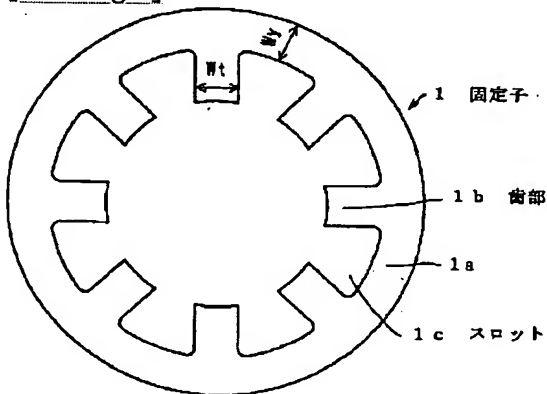
[Drawing 1]



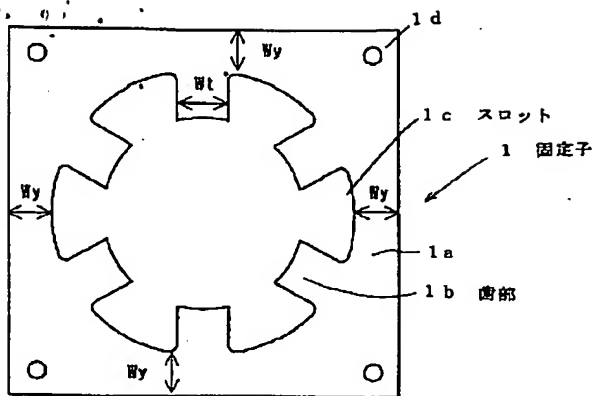
[Drawing 2]



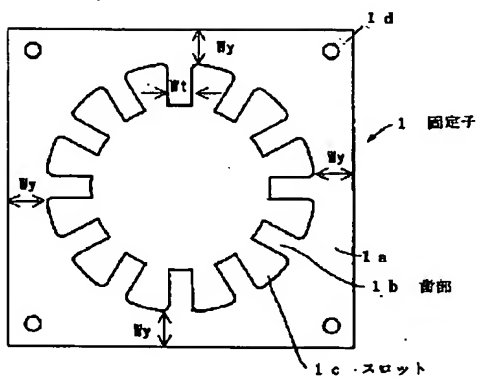
[Drawing 3]



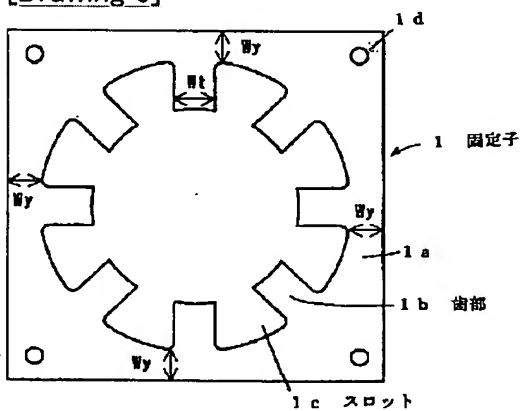
[Drawing 4]



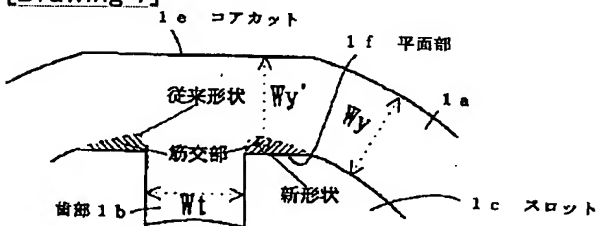
[Drawing 5]



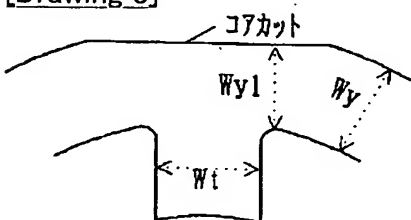
[Drawing 6]



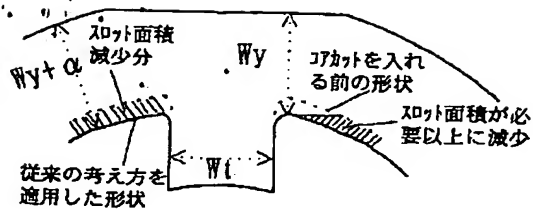
[Drawing 7]



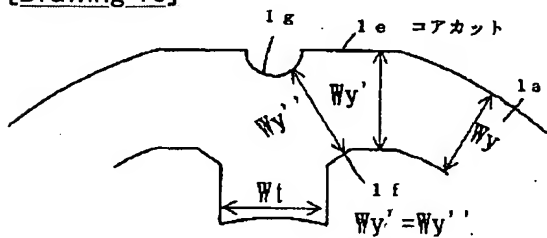
[Drawing 8]



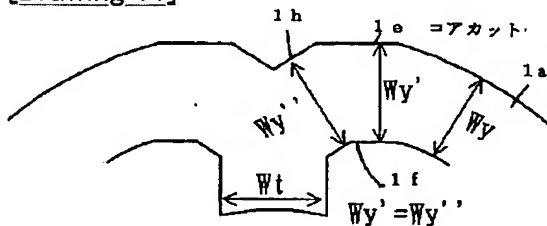
[Drawing 9]



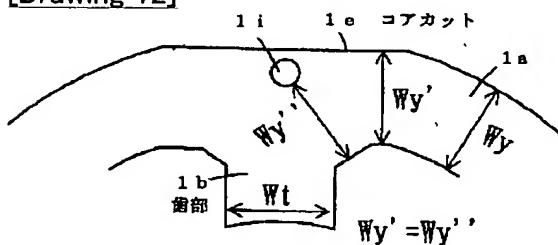
[Drawing 10]



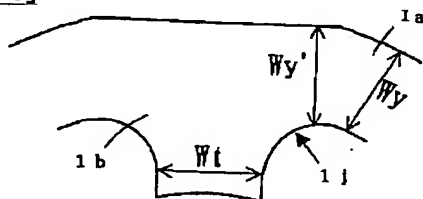
[Drawing 11]



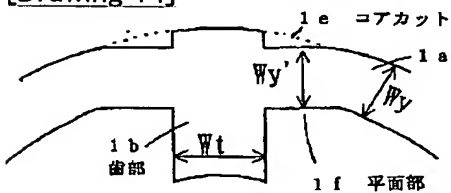
[Drawing 12]



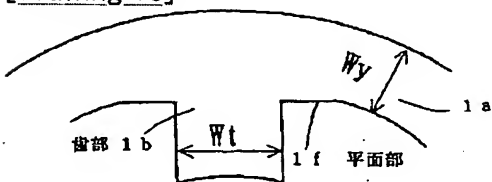
[Drawing 13]



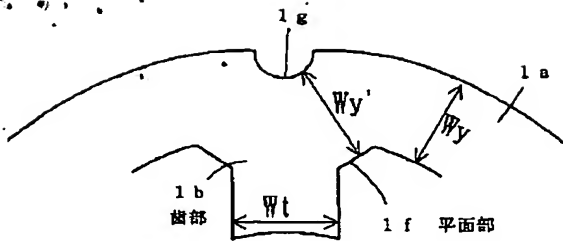
[Drawing 14]



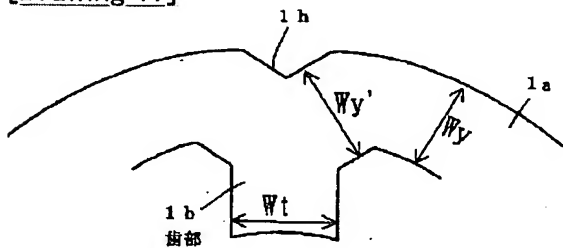
[Drawing 15]



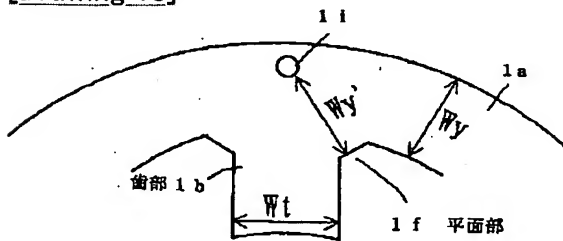
[Drawing 16]



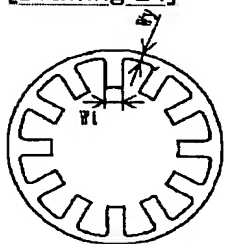
[Drawing 17]



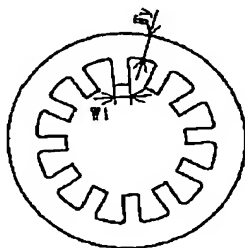
[Drawing 18]



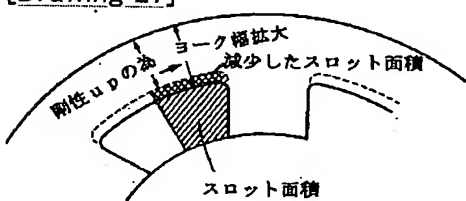
[Drawing 24]



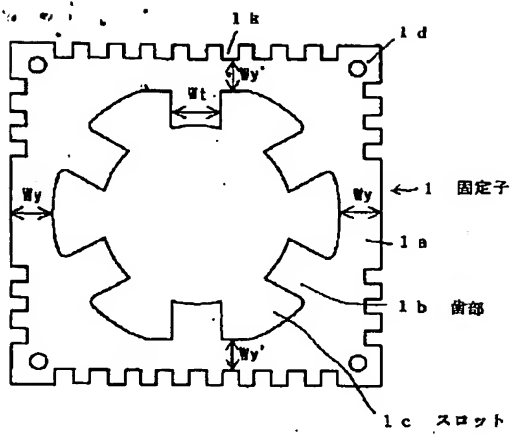
[Drawing 25]



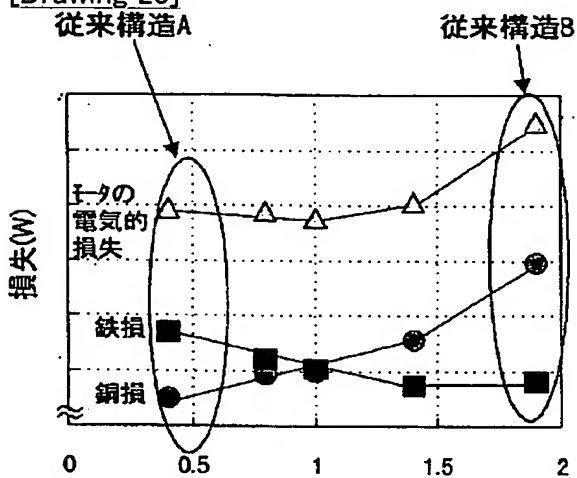
[Drawing 27]



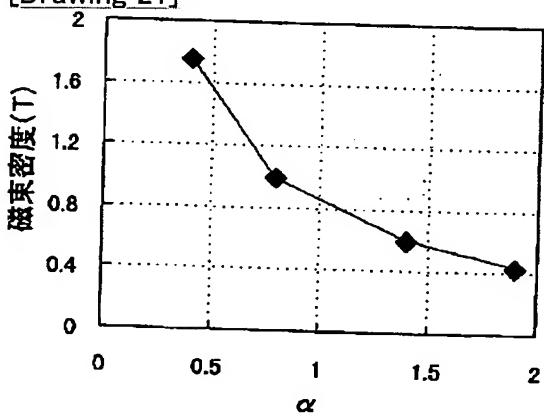
[Drawing 19]



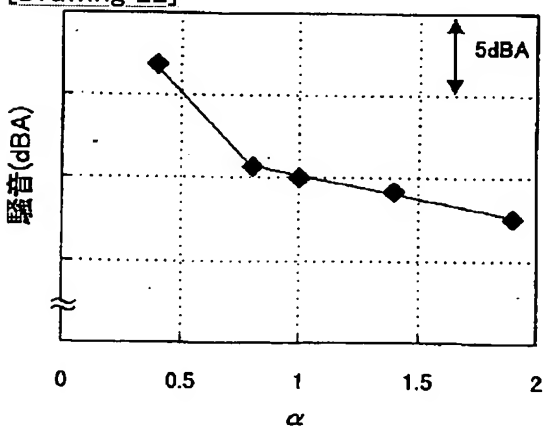
[Drawing 20]



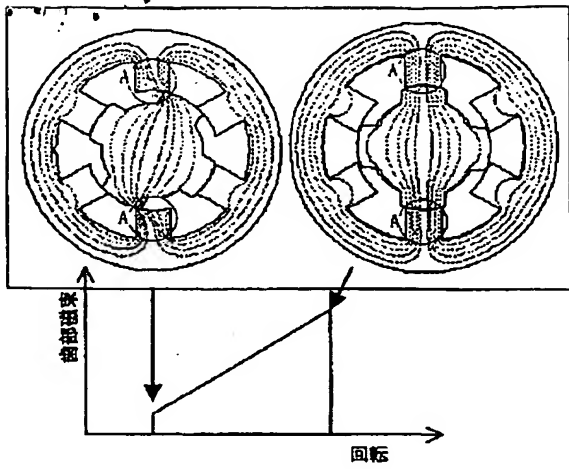
[Drawing 21]



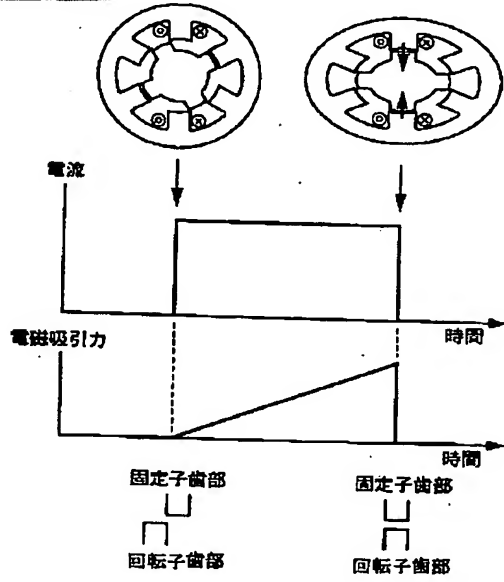
[Drawing 22]



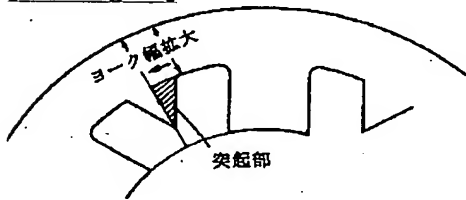
[Drawing 23]



[Drawing 26]



[Drawing 28]



[Translation done.]